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THE following communications were read:—

I. On Prof. Bessel's improved method of deducing the Longitude from a Lunar Distance. By Lieut. Stratford, R.N.

"In the *Astronomische Nachrichten*, Nos. 218, 219, and 220, Professor Bessel has given a new method of reducing a lunar distance, which, in my opinion, will render this celebrated problem as available to the landsman, for the determination of his longitude, as it has hitherto been to the seaman, and to a degree of accuracy limited only by the extent of our knowledge of the moon's true theory. With the view of making it more generally known in England, I here present the Society with an outline of Bessel's plan, accompanied by such remarks on the subject of lunar distances generally, as appeared to me requisite for the proper appreciation of its merits.

"In the *Nautical Almanac*, as well as in some of the ephemerides published in Europe, the distance of the moon's centre from certain objects is given at intervals of three hours, as it would appear to an observer placed at the centre of the earth: in other words, it is the true angular distance of the centre of the moon from the star, corrected for aberration only. This distance being independent of geographical position, would be observed at the same *absolute* moment of time at all places; if, therefore, we know the *relative* times under different meridians at which the phenomenon occurs, we obtain immediately, as in the case of an eclipse of the moon or of *Jupiter's* satellites, the difference of those meridians.

"An observation, however, of a distance at the surface of the earth, is made under very different circumstances, and is not, therefore, comparable with the tabulated distance until it has been reduced to the same state. In the tabulated distance, allowance has been made for aberration only, this operating equally at the centre and the surface of the earth. In the observed distance, the limbs of the objects have been taken instead of the centres—the positions of the objects are apparent not real, on account of refraction; and were there no atmosphere, they would still be different on account of parallax, produced by the change of position of the supposed observers.

" When the observation of the limbs at the surface of the earth has been corrected for semi-diameter and refraction, we have the true distance of the centres at the surface; and this being further corrected for parallax, we have it as it would appear at the centre, and in a fit state for comparison with the tabulated distance.

" All the various approximate methods of reducing a lunar distance are founded on the same principle, viz.

" There are given two triangles whose sides are respectively the *apparent* zenith distances and the *apparent* distance, and the *true* zenith distances and the *true* distance, the angle at the zenith being common to both triangles.

" The sides of the first triangle are given by the observations, and the angle at the zenith thence deduced. The observations being corrected for refraction and parallax, furnish two sides of the second triangle, with which, and the included angle, viz. the angle at the zenith already found, the third side, or the true distance, is obtained.

" The accurate solution of the problem requires,—

" 1. That we know the exact state of the atmosphere as regards temperature and density, in order to the obtaining the correct amount of refraction.

" 2. That we know the apparent altitude of the centres of the objects. The vertical semi-diameters should, therefore, be corrected for refraction before they are applied to the observations of the limbs.

" 3. The angles at the star and moon with the zenith, in order to an accurate estimate of the effect of refraction on the oblique semi-diameters lying in the circle passing through the centres of those objects.

" 4. That we know our latitude, an element particularly necessary in the proper reduction of every thing relating to the moon.

" Now, these are refinements that the sailor never dreams of, and perhaps they may be considered as of little or no importance, when he can scarcely be expected, under ordinary circumstances, to have his primary element, the *time*, correct to within any thing like the amount of error produced on the longitude by the omission of the whole of the minute corrections. He is satisfied with the diameters as given in the *Nautical Almanac*, with *mean* refractions and *equatorial* parallaxes; and with these he reduces, by some of the simplest approximative methods, his observation made at the surface to what it would be if made at the centre, without regarding the spheroidal figure of the earth. Not so, however, the landsman; he has his transit and clock, therefore his time to the greatest possible degree of accuracy; he is fixed, his latitude ascertained, his meteorological instruments about him; in short, he has every facility for obtaining accurate data for the rigid solution of the problem.

" Bessel's method is new in application, though not in principle; it is what we are accustomed to in every day's practice; it consists in the reduction of the tabulated quantities for the centre to compare with instrumental results at the surface, instead of the reduction of the observations themselves for comparison with the central quantities, the method commonly pursued.

"To illustrate the method,—Suppose a person at Paris, the difference of longitude of which from Greenwich is tolerably well known, to observe the distance of the moon from a star; it is very clear, that with the knowledge of the time of observation, we could compute, with the aid of the *Nautical Almanac* constructed for the meridian of Greenwich, the distance at that time, and that it ought to agree precisely with the observation, the only possible cause of disagreement, if any, being the inaccuracy of the lunar tables.

"Suppose the tables to be accurate, but that we do not know exactly the difference of longitude, what would be the consequence? A certain disagreement between the computed and observed distance, and attributable entirely to an erroneously assumed difference of longitude; for, as all our data for the computation of the distance was taken from the *Nautical Almanac*, for a time, of which the assumed difference of meridians is a component part, the data must be wrong, because the Greenwich time is not accurately known.

"If we knew, however, the variation of the distance of the bodies for one second of time, this, and the difference of the results, affords us a ready means of correcting our assumed longitude, and thus of approximating to any desired degree of accuracy, just as in the analogous case of an observed occultation.

"Some of the principal advantages of Bessel's method are, 1st, he obtains his data from the best possible sources, and thus arrives at the accurate value of the corrections; 2d, that by the mode of applying the corrections he never vitiates the instrumental result; 3d, the altitudes are unnecessary, an observation of the distance and the time being all that is required; 4th, the observation may be repeated at any time, and multiplied without limit.

"The chief labour of executing Bessel's method would fall upon the computers of ephemerides. In addition to the distances for every third hour, there would be required the angle at the moon formed by great circles passing through the sun and the pole; the log. sin. of horizontal parallax, and the log. of the semi-diameter of the moon, the star's meridian distance and its declination, together with logarithms of certain quantities, required in conjunction with the latitude, for the reduction of the tabulated geocentric quantities to their proper values for the spheroid, previously to the application of parallax.

"With an ephemeris containing these values, the difference of longitude is obtained as follows:—

"M. Bessel supposes the difference of longitude m between the place of observation and the meridian for which the ephemeris is made, to be approximately known, and proceeds to find the correction x from a comparison of the observed distance D′, of the moon's limb from a star, and the computed distance obtained from the time of observation T, and the data taken from the ephemeris; that is, for the Greenwich time (supposing the *Nautical Almanac* to be used) he takes from the ephemeris the geocentric distance of the moon from the star and the other quantities. With the corrections, and the given latitude, he reduces the elements, as given for the centre, to

what they would be at the point of intersection of the vertical with the polar axis, or, as it is generally termed, corrects those elements for the spheroidal figure of the earth. He then further corrects that distance for parallax; and lastly, for refraction, the final result D compared with observation, gives

$$\text{the correction } x = \frac{D' - D}{n'}$$

where n' is the variation of D for one second.

"He first solves the problem rigorously, and afterwards shews the seaman what may be thrown overboard, without much affecting the result as regards his peculiar circumstances, and gives formulæ for the carrying out of his method, which, with a very superior degree of accuracy, costs about a similar amount of labour with many of the methods in general use.

"I am much gratified in being able to inform the Society, that an ephemeris on Bessel's plan, for the year 1834, is now in progress, under the direction of Professor Schumacher."

II. Transits of the Moon with Moon-culminating Stars, observed at Cambridge Observatory, in the month of February 1833.

		Time by the Transit Clock. h m s	Daily losing rate. s
Feb. 2.	*d* Geminorum	6 41 20,44	1,60
	Moon 1 L.....	7 15 6,79	
	l Geminorum	7 45 42,90	
3.	*l* Geminorum	7 45 41,07	1,89
	Moon 1 L.....	8 22 42,37	
	ϑ Cancri	8 34 57,43	
	A. S. C. 1098.....	8 49 30,52	
4.	*q* Cancri.....	9 9 23,32	2,20
	Moon 2 L.....	9 31 21,44	

III. On the Map of *Jupiter*. By Professor Airy.

An account of this communication, the reading of which is not yet finished, will appear in the next Monthly Notice.

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